Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

ON NUMERICAL ORDER IN THE BRANCHING OF SOME CONIFERÆ.

BY THOMAS MEEHAN.

In a paper entitled "Adnation in Coniferæ," read at the Chicago meeting of the American Association for the Advancement of Science, and which was published in the "Proceedings" for 1868, I pointed out that the true leaves of Coniferæ were mostly adherent to the stem—not merely "decurrent" as is usually said of some of them; and that the vigor of the axis or stem was the measure of the adhesion. I now propose to show that axial vigor also determines the law of branching in some cases, and that the branching is on a numerical plan.

In the most vigorous growths of *Thuja occidentalis*, the common American arbor vitæ, the leaves are almost wholly united with the axis, only the delicate sharp awns are free. These are arranged in pairs, one leaf opposite the other. The upper pair alternates with the lower (decussate). A branch appears at the eighth node; and always at the eighth node when the vigor of the branch remains the same. As the axis weakens the branches appear at the sixth node. This is the general average. With greater weakness the fourth node gives birth to the branch; and finally as the plant takes on its frondose flattened form, a branch pushes from every alternate node. But in no case does a branch push at an odd number. They are always from the second, fourth, sixth, or eighth node.

In *Thuja gigantea*, Nutt., the same law prevails, the sixth and eighth being more numerous.

In *Libocedrus decurrens* all appear to be on the alternate plan. I have seen no instance, even in vigorous shoots, where the branches push otherwise than from every second node. This is also true of *Chamæcyparis Lawsoniana*, Parl.; and of *C. obtusa*, Sieb., *C. pisifera*, and *C. retusa*—all probably varieties of one thing.

In *Biota orientalis*, the branching is mostly from the fourth node, occasionally from the second or sixth; rarely one will come from the third and odd number. In the curious variety *B. O. pendula*, Parl., where the plant has lost or never achieved the power to produce frondose branches, the numerical order is lost: branchlets push at any indefinite point along the stem.

In *Chamæcyparis sphæroidea*, Spach., the American white cedar, the branching is pretty regular at the fourth node, sometimes from the second, rarely from the fifth.

In *Chamæcyparis nutpænsis*, Spach., the yellow cedar of the Pacific Coast, the course is the same as in the American arbor vitæ.

Sometimes in very stout shoots of this plant the leaves will be in whorls of three. It is curious to note then that the branching is on the odd numbers; either at three, five, or so on; but yet not in a regular graded series as in its normal condition and in the arbor vitæs. I have counted as many as fifteen nodes without a branch, and this absence of order in branching also exists in junipers. In these the leaves are mostly in threes, though still decussate, and the branching takes place at the odd numbers, and is irregular.

Callitris quadrivalvis has four leaves in a whorl, and here again we have the irregular branching of the junipers.

The result of these observations is that in a large number of cases the frequency of branching is in company with declining vigor; that presence of leaves in an opposite pair is favorable to a regularity of branching on even numbers; and that whorls of three or more are associated with irregular branching on odd numbers.

It is proper to remark that this branching has reference to the growth of one season. There are axillary dormant buds at every node, which may push according to circumstances during any subsequent year.

In connection with this subject are some observations worthy of note, though not probably original. As soon as the branching at alternate nodes begins in *Libocedrus*, *Thuja*, *Biota*, and others, the frondose character commences. The pair of adated leaves just above the node which bore a branch, is much contracted. These are always on the upper and lower faces, and are known as the dorsal leaves. The next pair of leaves are more developed, more free from cohesion with the axis, and from one of them a branchlet usually springs. These are the marginal leaves. Usually the branchlets, one from a node and from every second node, are alternate with the ones above and below it; but when the branchlet pushes from the main branch, the first series of two or sometimes three are one above another, and on the upper side. The flattened frondose form is the result of this plan of development. Rarely two branchlets will proceed from each node, one from the axil of each opposite leaf.

In some species each succeeding pair of cohering leaves are of equal length and strength. In the *Thujas* and in *Chamæcyparis Lamsoniana* this is characteristic; but in *Libocedrus decurrens*, and *Chamæcyparis obtusa*, and allies, every first pair succeeding a branchlet, and which on the flattened conditions constitute the dorsal pair, are very much abbreviated and shortened, so much indeed as to scarcely proceed beyond the line of the lower pair, and thus some writers have been led to describe these plants as having 4-verticillate leaves.

The seedling or first year's growth of *Biota orientalis* exhibits this subverticillate character. The first pair of leaves succeeding the cotyledons is so near as to appear almost two of a series of four cotyledon lobes. For many successive nodes the leaves appear to be 4-verticillate.

In regard to the early leaves of coniferous plants, those which follow the cotyledons are nearly free, having little cohesion with the stem or "decurrence," as botanists say. As the axis becomes thicker, or, as I have termed it in the paper referred to, endowed with more vitality, there is less of the free portion and more of the adnated or cohering, until in *Pinus* there is nothing left but a thickened bed or *pulvinus;* and the axial bud which generally marks the diverging place of the proper leaf has to push and in a difficult way perform the function of leaves. If any thing tend to check the vitality of the tree, so that the axial buds do not develop, the adnating power is weakened, and the true leaves again become free from the stem. This is seen in *Pinus edulis*, Engl. At any time through its existence, where the branches are weak by being shaded or starved by other branches, the *pulvini* develop into true leaves, and the axial bud, usually producing two "needles," does not push. Street trees and osier willows when annually trimmed, though the subsequent growth is vigorous, increase their trunks slowly in girth, and die much earlier than uncut ones. Thus their vitality is impaired. Some pine trees when cut down push up strong sprouts, and these will often have the pulvini developed into true leaves as in the weakened *Pinus* *edulis.* I have shown already, in the paper before referred to, that *Thujopsis borealis* (*Chamæcyparis*, *Nutkænsis*, Spach.) also throws out free leaves always in the weakened cutting state. In some garden varieties of *Thuja* and *Biota* the weak axis of the seedling condition remains throughout many succeeding years of growth. In all these cases the leaves are free. These free leaved forms are still regarded by some excellent European botanists as species of unknown introduction, although, as stated in my paper on "Adnation in Conifera," their derivation from *Thuja* and *Biota* is founded on direct evidence. I refer to this incidental matter chiefly to add the new observation, in connection with the leading points of the present paper, that with their weakened condition, the regular numerical order of branching, as noted in the fully developed forms, does not exist.

I do not suppose this law of vital vigor so far as developed will account for all the phenomena of free or adnated leaves; or for all the numerical relations of branchlets to the nodes. I have myself pointed out some apparent exceptions, but I trust I have made it clear that it performs no mean part in the order of these things.